Document details

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Toward Financially Viable Phytoextraction and Production of Plant-Based Palladium Catalysts (Article) (Open Access)

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Abstract

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Although a promising technique, phytoextraction has yet to see significant commercialization. Major limitations include metal uptake rates and subsequent processing costs. However, it has been shown that liquid-culture-grown Arabidopsis can take up and store palladium as nanoparticles. The processed plant biomass has catalytic activity comparable to that of commercially available catalysts, creating a product of higher value than extracted bulk metal. We demonstrate that the minimum level of palladium in Arabidopsis dried tissues for catalytic activity comparable to commercially available 3% palladium-on-carbon catalysts was achieved from dried plant biomass containing between 12 and 18 $g \cdot kg^{-1}$ Pd. To advance this technology, species suitable for in-the-field application: mustard, miscanthus, and 16 willow species and cultivars, were tested. These species were able to grow, and take up, palladium from both synthetic and mine-sourced tailings. Although levels of palladium accumulation in field-suitable species are below that required for commercially available 3% palladium-on-carbon catalysts, this study both sets the target, and is a step toward, the development of field-suitable species that concentrate catalytically active levels of palladium. Life cycle assessment on the phytomining approaches described here indicates that the use of plants to accumulate palladium for industrial applications has the potential to decrease the overall environmental impacts associated with extracting palladium using present-day mining processes. © 2017 American Chemical Society.

SciVal Topic Prominence

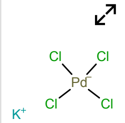
Topic: Cyanide | Cyanides | Free cyanide

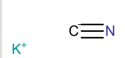
Prominence percentile: 65.821

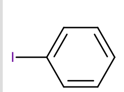
Chemistry database information

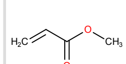
Substances

Pd









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Engineering controlled terms: Biomass; Catalyst activity; Catalysts; Environmental impact; Industrial plants; Life cycle

Engineering uncontrolled terms: Field application; Life Cycle Assessment (LCA); Mining process; Palladium catalyst; Palladium on carbons; Phytoextraction; Processing costs; Willow species

Engineering main heading: Palladium

EMTREE drug terms: palladium; soil pollutant

GEOBASE Subject Index: angiosperm; biomass; catalyst; concentration (composition); environmental impact; extraction method; life cycle analysis; mining; palladium; phytoremediation

EMTREE medical terms: Arabidopsis; Article; biomass; catalysis; catalyst; cultivar; environmental impact; extraction; life cycle assessment; mine tailings; Miscanthus giganteus; mustard; nonhuman; phytomining; plant; plant growth; rhizome; willow; mining; soil pollutant

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